Increasing Precision in Describing Thresholds, Drivers and Indicators

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Presentation Objectives

I. Evaluate the ecological foundation upon which alternative rangeland evaluation procedures have been developed.

II. Describe a unified framework to develop, interpret and apply ecological thresholds for land management.

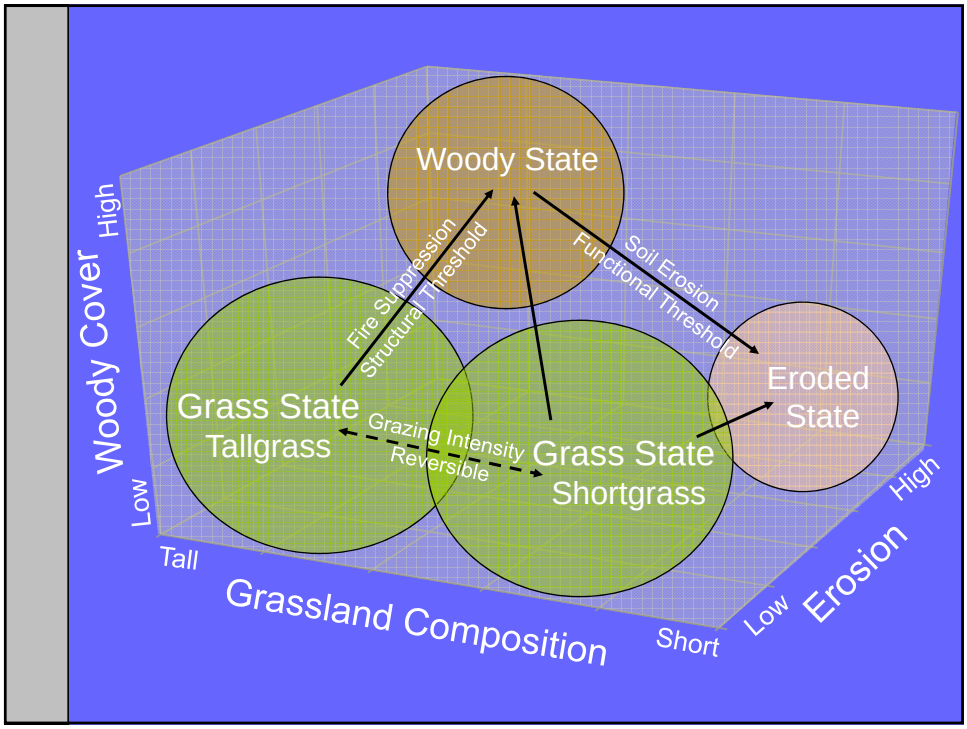
Rangeland Vegetation Dynamics

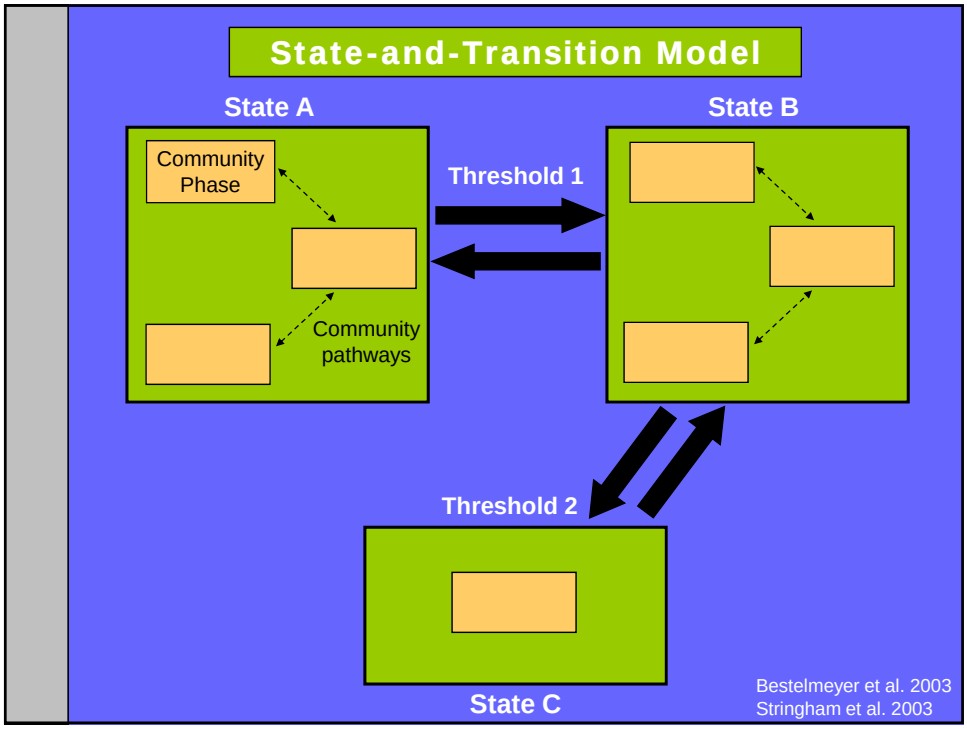
The evaluation of vegetation dynamics, primarily focused on relative changes in the species composition of plant communities, has long been a cornerstone of rangeland ecology.

Vegetation evaluation provides a means to:

1) identify rangeland resources for appropriate management options,
2) draw inferences concerning ecosystem function, and
3) assess the limits of ecosystem sustainability.

Consequently, a critical need exists for accurate and effective procedures to evaluate vegetation dynamics on rangelands.





Do We Understand Thresholds?

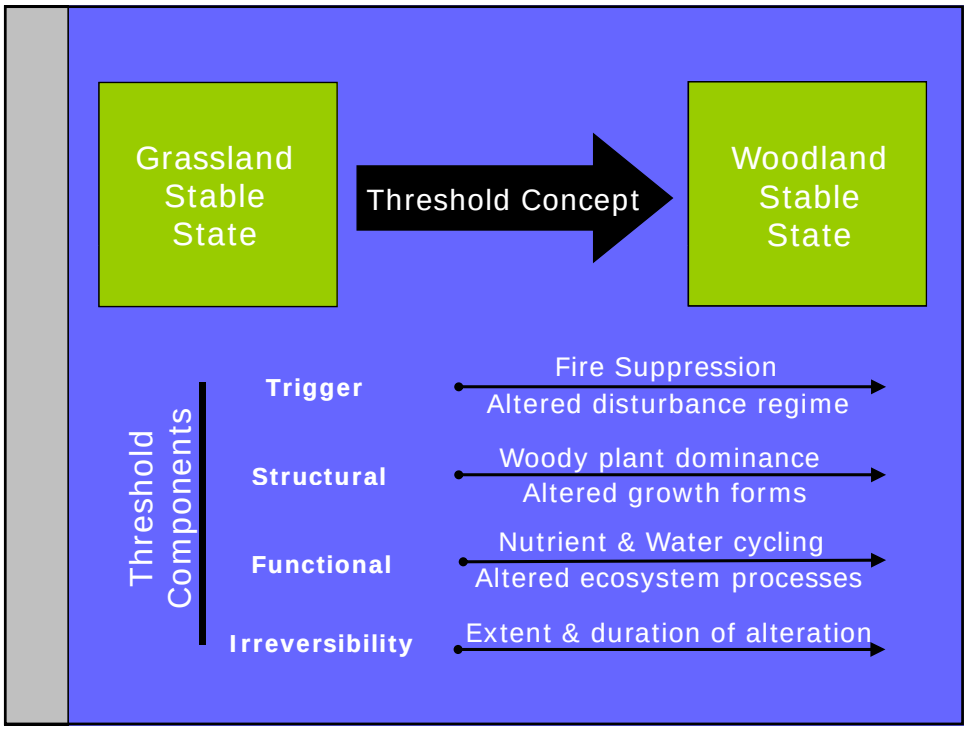
- What events initiate threshold development?
- What ecological mechanisms establish thresholds?
- At what point do thresholds become irreversible?
- Can thresholds occurrence be anticipated?
- Do all thresholds possess similar components?
- Can thresholds be applied to land management?

Threshold Definitions

Ecosystems may move from one stable domain to another and remain in an altered configuration – (Holling 1973)

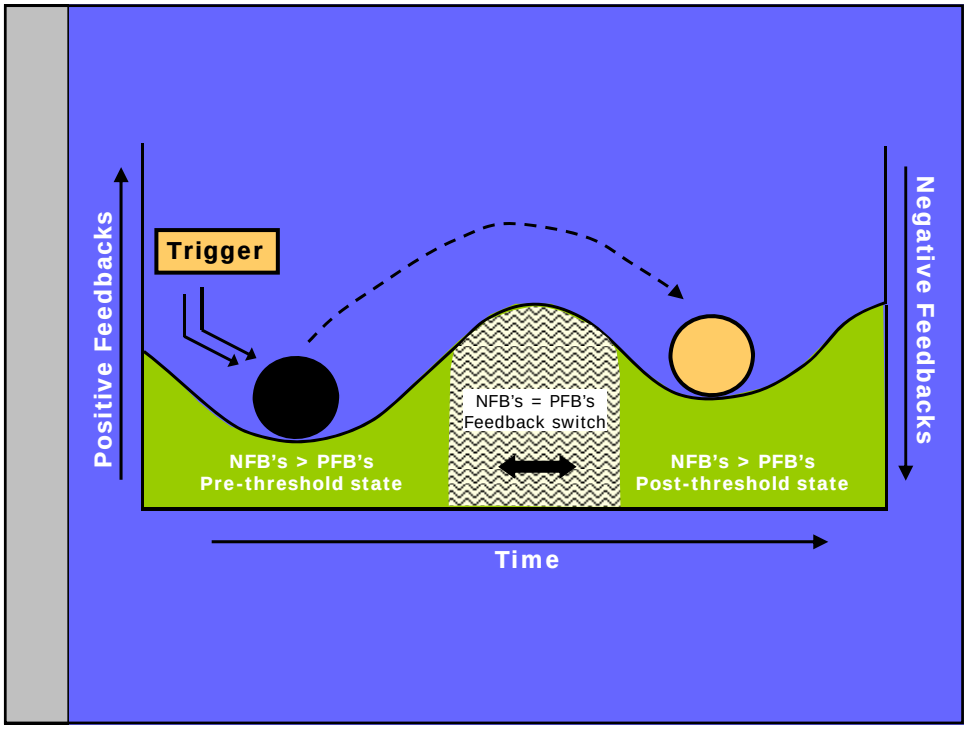
Boundaries in time and space between two states that are not reversible on a practical time scale without management intervention – (Friedel 1991)

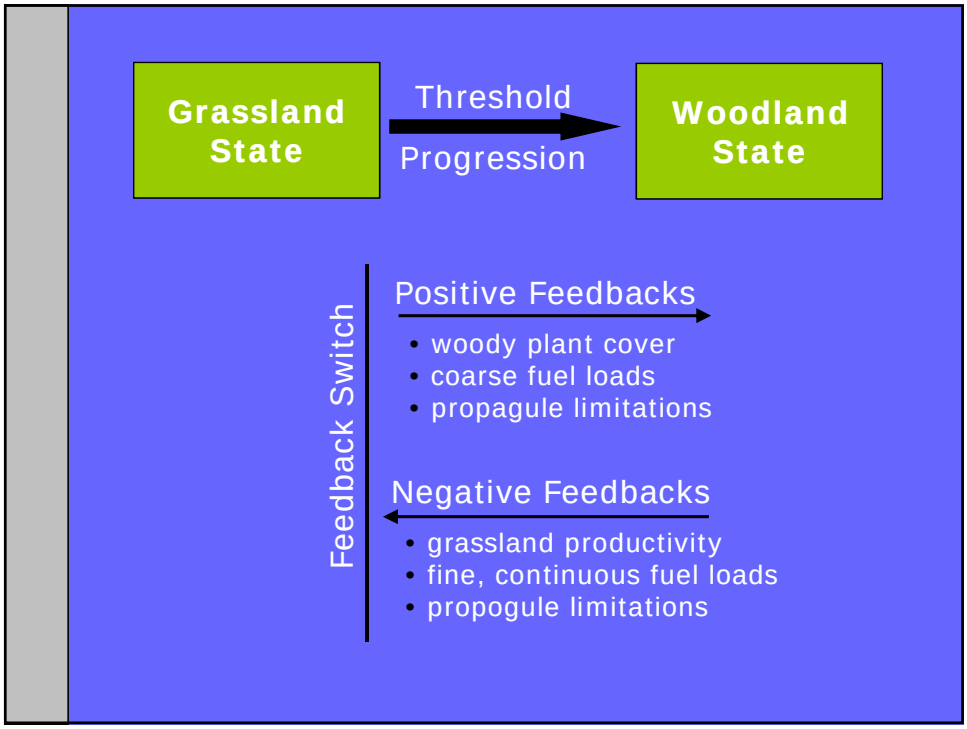
Boundaries in time and space between any and all states, such that one or more of the primary ecological processes has been irreversibly changed and must be actively restored before return to the previous state is possible – (Stringham et al. 2003)

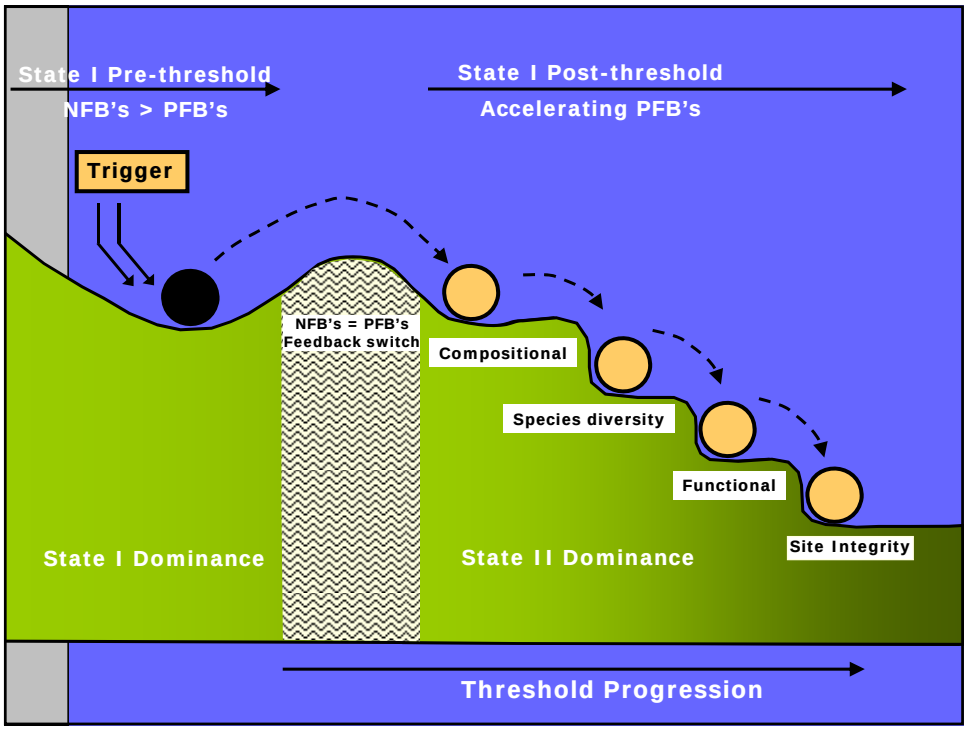


Threshold Components

- **Triggers** – event(s) that initiate threshold progression by inducing a switch from negative to positive feedbacks.
- **Feedbacks**- ecological processes that reinforce (e.g., negative) or degrade (e.g. positive) resilience of a stable state.
- **Threshold categories** – series of ecological processes that reduce resilience of the pre-threshold state during threshold progression.
- **Threshold trajectories** – developmental pathways of post-threshold states after a threshold has been exceeded.
- **Operational thresholds** – series of probabilities that determine threshold occurrence, trajectories, and reversibility.

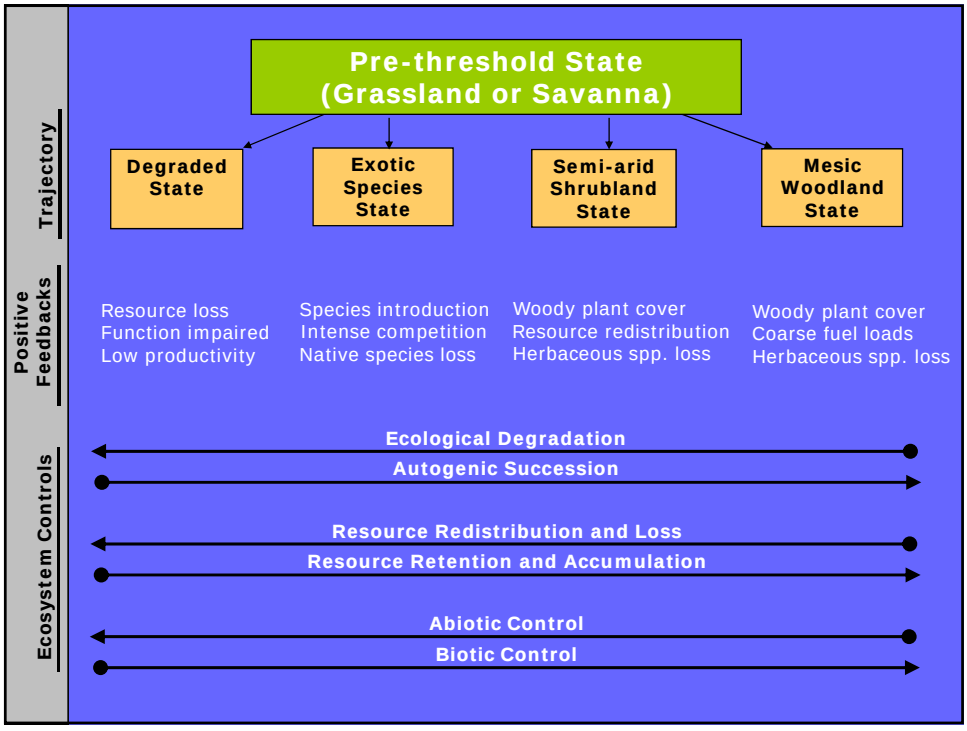


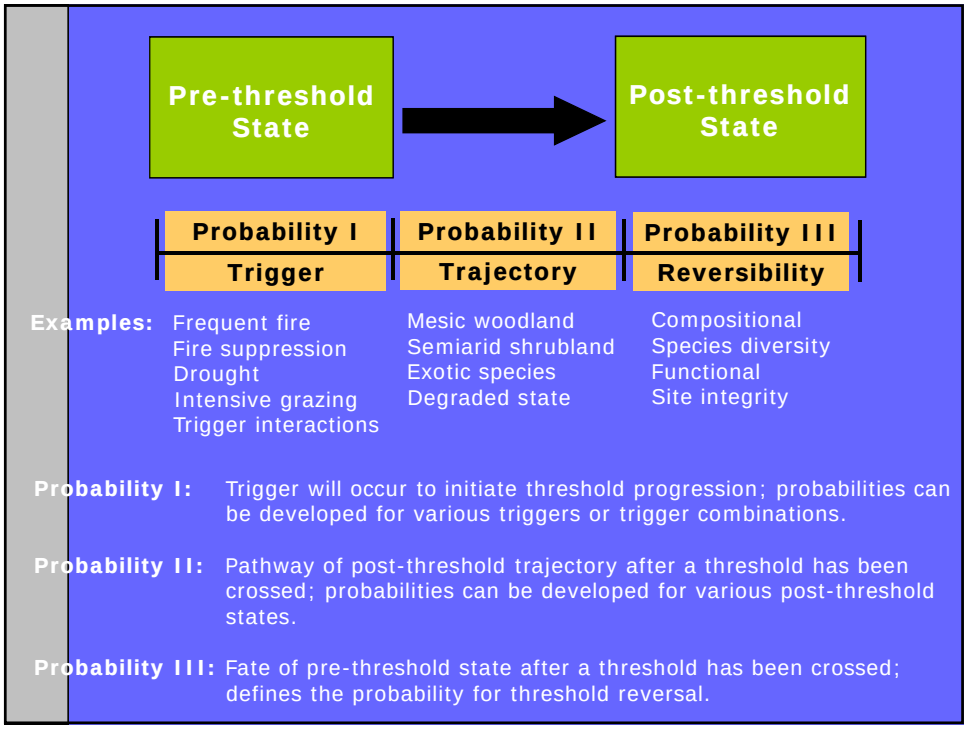

Grassland State
Threshold
Progression
Woodland State
Feedback Switch
Positive Feedbacks
• woody plant cover
• coarse fuel loads
• propagule limitations
Negative Feedbacks
• grassland productivity
• fine, continuous fuel loads
• propogule limitations

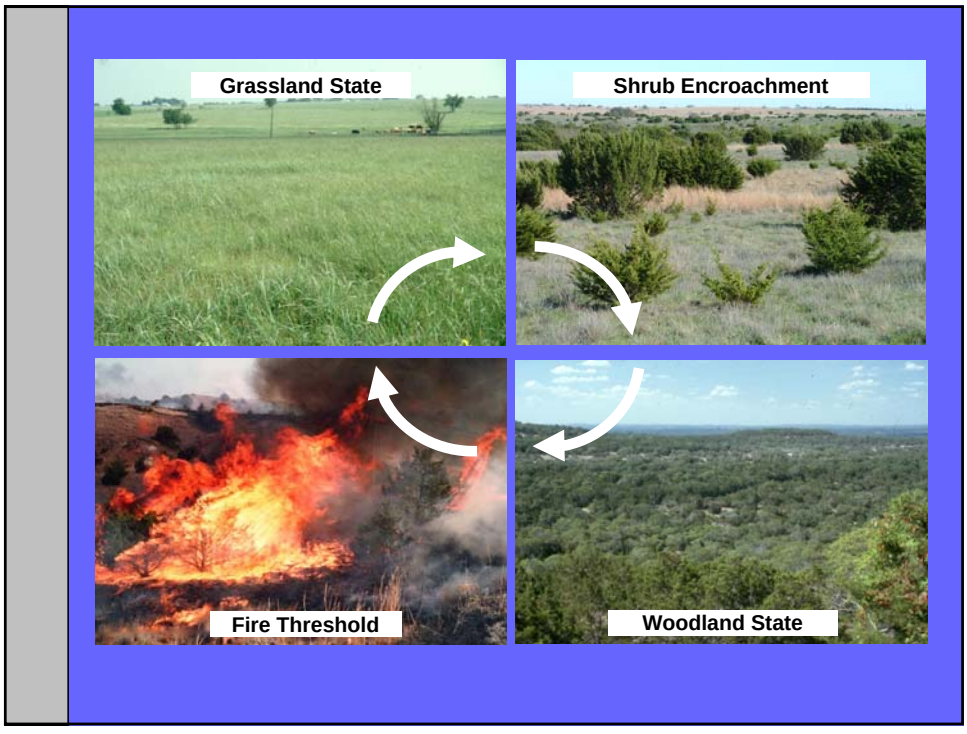

State I Pre-threshold
NFB's > PFB's
State I Post-threshold
Accelerating PFB's
Trigger
NFB's = PFB's
Feedback switch
Compositional
Species diversity
Functional
Site Integrity
State I Dominance
State II Dominance
Threshold Progression

Threshold Categories

- **Compositional category** – substantial modification of relative species and growth form composition, spatial vegetation distribution, and the presence of invasive species; removal of the dominant species from the post-threshold state will reverse the threshold.
- **Species diversity category** – species and genetic diversity of the pre-threshold state have become locally extinct; propagule addition will be required to reverse the threshold.
- **Functional category** – positive feedbacks have progressed to the extent that ecological processes will no longer support dominants of the pre-threshold state; restoration prescriptions will be required to reverse the threshold.
- **Site integrity category** - degradation has progressed to the extent that site characteristics of the pre-threshold state have been greatly modified; opportunity for threshold reversal has been lost.




Pre-threshold State
Post-threshold State
Probability I
Trigger
Probability II
Trajectory
Probability III
Reversibility
Examples:
Frequent fire
Fire suppression
Drought
Intensive grazing
Trigger interactions
Mesic woodland
Semiarid shrubland
Exotic species
Degraded state
Compositional
Species diversity
Functional
Site integrity
Probability I: Trigger will occur to initiate threshold progression; probabilities can be developed for various triggers or trigger combinations.
Probability II: Pathway of post-threshold trajectory after a threshold has been crossed; probabilities can be developed for various post-threshold states.
Probability III: Fate of pre-threshold state after a threshold has been crossed; defines the probability for threshold reversal.


Grassland State
Shrub Encroachment
Fire Threshold
Woodland State